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**(56) Related Art**  
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## Drive Device for a Front-Loading Washing Machine

### ABSTRACT

The drive in the form of a direct drive device for a front-loading washing machine is structured to enable adequate cooling of the stator 5 windings by the ambient air so that the flat motor of adequate size cannot overheat in proper operation. Furthermore, it is important that the motor can be preassembled in its manufacturing plant.

To this end, a stator (10) is connected to a stiff carrier part or, instead of the stiff carrier part, with the rear wall (6) of the washing 10 liquid container (1) and comprises a central bearing sleeve (22) for the shaft (7) of the laundry drum (4) and for a hub (31) enclosing the shaft of the rotor. The hub (31) is mounted in a central position at the outer end of the shaft. The tub has a plurality of openings, between its hub 15 and the circumferential portion, and a bell-shaped flange on its periphery pointing toward the tub. With its magnetisable poles (14), which are distributed over the inner periphery of the bell-shaped flange, the rotor faces from the outside across a minimum air gap to the lamination stacks (32) which are distributed at the stator (10) and provided for reception of excitation windings (12) of the stator (10).

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**Invention Title:** Drive Device for a Front-Loading Washing Machine

The following statement is a full description of this invention, including the best method of performing it known to me/us:-

Drive device for a front-loading washing machine

The invention concerns a drive device for a front-loading washing machine with a laundry drum which is borne overhung by way of an at least horizontal shaft within a bearing sleeve of a stiff carrier part 5 mounted at the rear wall of a washing liquid container and which is driven directly by a flat motor likewise mounted at the rear wall of the washing liquid container.

Such drive devices are known from the DE 39 27 426 A1 and the DE 43 41 832 A1. In these, the stator of the motor constructed as 10 collectorless external rotor direct current motor are fastened directly on the bearing sleeve of the stiff carrier part. The shaft is borne in the bearing sleeve and at its outer end connected with the rotor of the motor to be secure against relative rotation. This rotor is here a so-called external rotor which as pot engages over the 15 stator windings and carries poles constructed as permanent magnets. In the automatic washing machine according to the DE 43 41 832 A1, the motor is additionally surrounded by an insulating hood which attenuates noises radiated by the motor directly to the surrounding atmosphere.

20 The known drive devices encapsulate the stator, which is exposed to an appreciable temperature loading due to heat caused by the current in its windings, by a rotor structured in pot shape (and additionally by the sound-insulating hood in the case of the DE 43 41 832 A1) so greatly that a cooling of the motor does not take place at 25 all. This is enhanced above all by a direct driving motor of that kind because of its necessarily low own rotational speeds can hardly come to an own cooling by the rotating rotor. The known drive devices are therefore practically only usable when they are protected against rapid overheating by an external cooling.

30 The known drive devices can beyond that not be delivered as already ready-assembled motor to the manufacturing works of washing machines. Their stators and rotors must be delivered separately and be assembled each with the other only in the washing machine works. Since special assembly equipments for the completion of motor 35 assemblies are as a rule not present in a washing machine works and

also not desired, the completion of the stator assembly to be connected with the liquid container system by the external rotor assembly can as a rule take place only inaccurately. Since extremely high demands are made on the maintenance of a small air gap, which as far as possible is always equally great for each specimen, between the stator poles and the 5 rotor poles as well as on the centred bearing, which demands are not to be fulfilled in the aforementioned assembly in a washing machine factory, the known drive devices are practically usable only very conditionally.

It is desirable to structure the initially denoted drive equipment that, on the one hand, a cooling of the stator windings by the ambient air can be assured readily and the 10 motor cannot overheat in orderly operation with dimensioning doing justice to the demands as well as, on the other hand, the motor can be completed and tested in the works of the motor manufacturer before it is to be built in at a washing machine manufacturer.

It is the object of the present invention to substantially overcome or at least 15 ameliorate one or more of the above disadvantages.

Accordingly, the present invention provides a drive device for a front-loading washing machine having a washing liquid container and a laundry drum, said laundry drum being mounted by way of a substantially horizontal shaft within a bearing sleeve of a stiff carrier part, said stiff carrier part being mounted at a rear wall of said washing 20 liquid container and said shaft being driven directly by a flat motor mounted at said rear wall of said washing liquid container, said flat motor having a rotor and stator;

wherein said stator is connected either to said stiff carrier part or with said rear wall of said washing liquid container, said stator comprising a central bearing sleeve for receiving a hub of said rotor and said shaft of said laundry drum, said shaft being 25 encompassed by said hub;

further wherein said rotor includes a bell-like flange at its circumference, facing said washing liquid container, and a plurality of openings between said hub and said flange, said rotor being centred and fastened to an end of said shaft distal to said laundry drum; and

30 further wherein said rotor includes magnetisable poles, distributed at the internal periphery of said bell-shaped flange, and said stator includes lamination stacks, distributed on said stator, such that said poles are radially opposed across a minimum air gap to said lamination stacks, said lamination stacks providing for the reception of excitation windings of said stator.



The structuring of the preferred embodiment is such that the motor has an open form of construction, the heat-generating components of which, which is above all the stator windings, can be cooled by the ambient air from all sides. Even the low rotational speed of the motor during the washing operation then still suffices for the rotor producing a heat-removing air movement.

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In this manner, the motor can beyond that be assembled and tested completely in the manufacturing works of the motor supplier. The assembly aids and the test aids suitable for this are available there so that always equally accurately assembled motor assemblies can be 5 supplied to the washing machine works. Here, this assembly can, in place of a cast carrying spider usual at this place or additionally thereto, be mounted to the rear wall of the washing liquid container system. For this purpose, the stator of the complete motor is fastened by means of several screws at any suitable places of the rear 10 wall of the washing liquid container. Then, the shaft of the laundry drum is plugged from the front into the hub of the rotor, which is already connected with the stator by way of the rolling bearings, and secured from the rear by a central screw. These operating steps are extremely similar to those of the fastening of a carrying spider and a 15 belt pulley according to the hitherto usual washing machine constructions so that no completely different working steps have to be learned by the assembly personnel.

When parts of the rotor are constructed, according to a particularly advantageous refinement of the drive equipment according 20 to the invention, for enhancement of an air movement arising during its rotational movement, the rotor can produce sufficient cooling air for the stator windings already at low rotational movement, for example at the rotational speed for washing. For this purpose, one can for example resort to a spoke-like shaping of the stator disc and 25 a fan-like structuring of these spokes.

When the motor according to an advantageous embodiment of the invention is an electronically commutated direct current motor, the heat development can be kept extremely small beyond this. Maintenance operations are not required (no carbon brushes). The service life is 30 limited merely by an eventual bearing wear.

In a particularly advantageous development of the invention, the rotor is constructed at least partially of an annular stack of dynamo iron sheets and permanent magnet segments arranged thereon. The permanent magnet segments result in a forceful torque and the dynamo 35 iron sheets form a particularly good magnetic return flux. The production of the required lamination stacks is relative uncomplicated

and favourable in costs due to automation of the stacking process.

Advantageously, the pole stacks of the stator are composed of dynamo iron sheets and carry coils with the excitation windings.

For the facilitated and reproducibly accurate assembly, the 5 centred connection of the stator to be secure against relative rotation at the shaft can be augmented by a shape-locking profiled shaft connection, profiled hub connection, fitted key connection, conical groove connection or keyway connection.

10 The motor can according to a further advantageous embodiment of the invention be constructed as so-called switched reluctance motor. In this case, the stator consists of a ferromagnetically relatively poorly conducting material. The build-up of the stator is comparable with that of the electronically commutated direct current motor. The 15 advantage consists in particular in a structuring of the rotor at more favourable costs (no expensive magnetic materials).

The invention is explained in the following by reference to an example of embodiment illustrated in the drawing. There show

20 Fig. 1 a schematic illustration of a washing liquid container of a washing machine with an internal, horizontally borne laundry drum, the drive shaft of which is borne together with the hub of the stator bell in the bearing sleeve of the stator and

25 Fig. 2 an enlarged detail view, which is illustrated partially in section, of the motor according to Fig. 1 mounted at the rear wall.

30 The washing liquid container 1 is borne overhung in a manner not more closely illustrated here in a likewise not illustrated housing of a washing machine. At its front wall 2, it has an opening 3 for the loading and unloading of the laundry drum 4, which is borne to be rotatable in the rear wall 6 of the washing liquid container 1 about the horizontal axis 5. The shaft 7, which at the rear wall 8 is connected with the laundry drum 4 to be secure against relative rotation, serves for this.

35 A motor 9, the stator support part 10 of which is connected with the rear wall 6 by way of the flange 11 to be secure against relative rotation, is mounted at the rear wall 6 of the washing liquid

container 1. Several stator windings 12 are distributed at the rearward surface of the stator support part 10 and during the rotation of the rotor 13 correspond in alternation with its poles 14, which here consist of permanent magnets and are likewise distributed in the manner of segments at the circumference of the rotor 13. The magnetic return flux of the magnet segments 14 is formed by a stack of dynamo iron sheets 16, which is laid into the bell flange 15. Thereby, the motor can introduce its driving torque directly by way of the shaft spigot 7 into the laundry drum 4. In that case, the stator 10 of the motor also takes up all bearing forces like a carrying spider replaced by it.

According to Fig. 2, the rear wall 8 of the laundry drum 4 is stiffened by a carrying spider 17, the hub 18 of which is connected with a shaft spigot 7 to be secure against relative rotation. The stator support part 10 at its outer circumference carries several, preferably three fastening eyes 23, which are arranged distributed over the circumference of the washing liquid container 1 and by means of screws 24 result in a firm connection with the washing liquid container 1 by way of straps 25 welded to the washing liquid container. The stator support part 10 is screwed (screws 19) to an assembly disc 20, which in its turn is screwed (screws 24) together with the washing liquid container 1 at the rear wall 6. Other than in this example, the stator support part 10 together with the assembly disc 20 can be executed in one piece. Then, the separate screw-fastening of the bearing part 21 for the stator poles (consisting of windings 12 and lamination stacks 32) with the assembly disc 20 would become superfluous.

The bearing sleeve 22 of the stator support part 10 forms bearing seats 26 and 27 for rolling bearings 28 and 29, the inner rings of which are plugged with a good fit onto the shaft spigot 7 of the laundry drum 4. At the outer end, the shaft 7 is plugged into the hub 31 of the rotor 13 and secured by means of a central screw 30 so that it connects the rotor 13 by way of its hub 31 and the inner rings of the rolling bearings 28 and 29 of the laundry drum 4 to be secure against relative rotation.

The rotor disc 13 is, for better ventilation and cooling of the

stator poles, equipped with passages 33 between its hub 22 and the bell flange 15 serving as carrier ring for the magnet segments 14. These passages can advantageously be so shaped at their edges that the access of cooling air through these passages is enhanced in the sense of a fan effect. To improve the cooling effect, so-called whirlers, which take care of a turbulence of the cooling air in order that it gets better contact with the stator windings, can still be arranged at the passages or in their proximity.

The motor is here constructed as electronically commutated direct current motor. It can however also be executed as so-called switched reluctance motor. In this case, at least the flange of the rotor or its inner bearing surface consists of a ferromagnetically relatively poorly conducting material. The build-up of the stator is comparable with that of an electronically commutated direct current motor. The advantage of the reluctance motor consists in particular in a structuring of the rotor at more favourable costs (no expensive magnetic materials).

For better securing against relative rotation between the rotor 13 and the shaft 7, the screw-fastening 30 of the rotor 13 at the shaft 7 can be augmented shape-lockingly by a not illustrated profiled shaft connection, profiled hub connection, fitted key connection, conical groove connection or keyway connection.

The claims defining the invention are as follows:

1. A drive device for a front-loading washing machine having a washing liquid container and a laundry drum, said laundry drum being mounted by way of a substantially horizontal shaft within a bearing sleeve of a stiff carrier part, said stiff carrier part being mounted at a rear wall of said washing liquid container and said shaft being driven directly by a flat motor mounted at said rear wall of said washing liquid container, said flat motor having a rotor and stator;

wherein said stator is connected either to said stiff carrier part or with said rear wall of said washing liquid container, said stator comprising a central bearing sleeve for receiving a hub of said rotor and said shaft of said laundry drum, said shaft being encompassed by said hub;

further wherein said rotor includes a bell-like flange at its circumference, facing said washing liquid container, and a plurality of openings between said hub and said flange, said rotor being centred and fastened to an end of said shaft distal to said laundry drum; and

further wherein said rotor includes magnetisable poles, distributed at the internal periphery of said bell-shaped flange, and said stator includes lamination stacks, distributed on said stator, such that said poles are radially opposed across a minimum air gap to said lamination stacks, said lamination stacks providing for the reception of excitation windings of said stator.

2. The drive device according to claim 1, wherein said rotor includes fan-like parts adapted to increase air movement arising during rotational movement of said rotor, for cooling the excitation windings of said stator.

3. The drive device according to claim 1 or 2, wherein said motor is an electronically commutated direct current motor.

4. The drive device according to claim 3, wherein said rotor consists at least partially of an annular stack of dynamo iron sheets and permanent magnet segments arranged thereon.

5. The drive device according to claim 3 or 4, wherein said lamination stacks of said stator are composed of dynamo iron sheets and carry coils with said excitation windings.

6. The drive device according to any one of the claims 1, 2, 4 and 5, wherein said motor is a switched reluctance motor.

7. The drive device according to any one of the preceding claims, wherein said centred fastening of said rotor to said shaft is shape-lockingly secure against relative



rotation by a profiled shaft connection, a profiled hub connection, a fitted key connection, a conical groove connection or a keyway connection.

8: A drive device for a front loading washing machine, said device being substantially as hereinbefore described with reference to the accompanying drawings.

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**Dated 13 April, 2000**

**Bosch-Siemens Hausgerate GmbH**

**Patent Attorneys for the Applicant/Nominated Person**

**SPRUSON & FERGUSON**

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FIG. 1

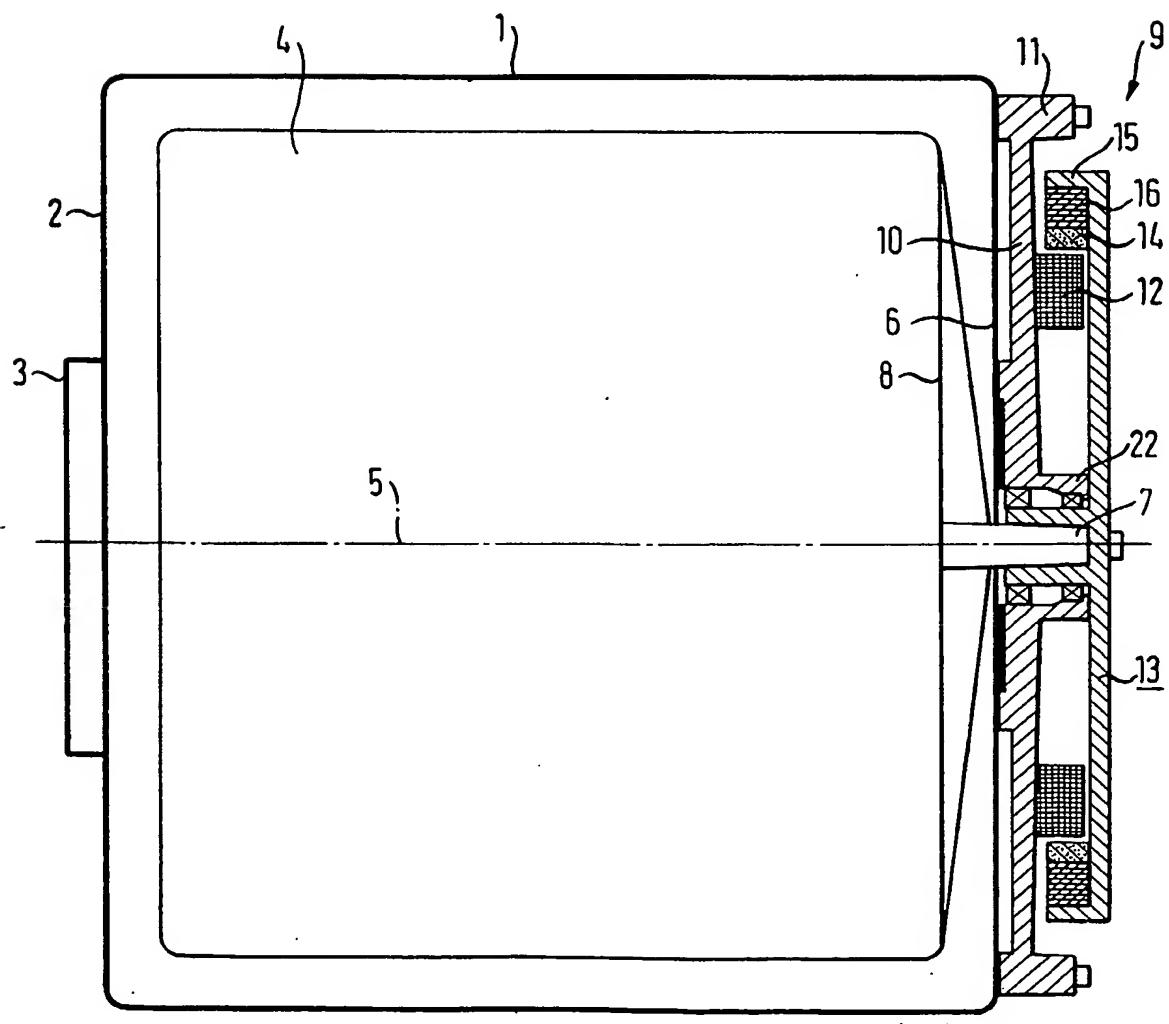


FIG. 2

